nish the shallow water with coral or rock for the haliotids. As geological changes altered the situation, certain portions of the range were separated by non-habitable regions. This left isolated populations which survived, perhaps in the original stage, perhaps altered somewhat. Perhaps we have several basic species represented in this situation, although the majority appear to belong to the genus or subgenus Padollus. Perhaps we have had several such distributions and separations in the past geological time.

The argument has been advanced that such distributions are the result of planktonic drift. If this is true, where are the intermediate stations? And also, if this is true, then the free-swimming stage must last far longer than is now known, since the distances are measured in the thousands of miles, and often against strong currents.

In conclusion, let us briefly review the known facts that we have concerning both Gondwana and the Haliotidae. Gondwana is supposed to have occupied portions of present-day South America and Africa, as well as the south Atlantic Ocean. This area was presumed to have submerged or was submerging during the late Paleozoic or Mesozoic. Such major geological changes take years to complete. This theory is based upon similarities of plant and invertebrate fossils and differences in terrestial vertebrate fossils. We may trace the haliotids back in geological history to the Cretaceous. We find certain species, that are obviously related to each other, living in isolated areas of what would have been Gondwanaland. Thus, if we accept the theory of Gondwana, it would be logical to assume that these species, or a common ancestor species, lived along the shores of this lost region. As the region sank into the depths, these isolated populations remained, and today represent relics of that past distribution.

Or perhaps this is all in error, and we are actually confronted with some remarkable cases of parallel evolution.

LITERATURE CITED

Camp, Charles L.
1952. Earth Song. Univ. Calif. Press.

Hinds, Norman E. A.
1952. Evolution of the California Landscape. Bull. 158, Div. of Mines, State of California.

McKee, Edwin D.
1948. Ancient Landscapes of the Grand Canyon Region, Ed. 18; Sun Printers, Flagstaff, Arizona.

Schuchert, Charles
1932. Gondwana Land Bridges. Bull. Geol. Soc. of America, Vol. 43.

Willis, Bailey
1932. Isthmian Links. Bull. Geol. Soc. of America, Vol. 43.

Gastropods from Clipperton Island

by

Leo G. Hertlein

Associate Curator, Department of Geology, California Academy of Sciences, San Francisco 18

and

Edwin C. Allison

Museum Paleontologist, Museum of Paleontology, University of California, Berkeley 4

This is the third contribution in a series of papers (see: The Veliger, vol. 1, no. 4, pp. 32-34; vol. 2, no. 4, pp. 94-95, pl. 22) dealing with the Indo-Pacific West American molluscan fauna of Clipperton Island, an isolated coral atoll in the eastern Pacific, about 670 miles southwest of Acapulco, Mexico.

Specimens on which this paper is primarily based were collected by the junior author with the assistance of other personnel participating in 1956 and 1958 Clipperton Island investigations by the Scripps Institution of Oceanography. Collections were taken from the beach, from the reef flat, and (by SCUBA diving) from off the edge of the reef flat to water depths of about 40 meters (130 feet). Conrad Limbaugh of the Scripps Institution of Oceanography, recently lost in a tragic diving accident, collected specimens

below 20 meters (65 feet). Specimens collected from the lagoon reflect past marine conditions when oceanic waters had free access.

Occurrences of all known Clipperton representatives of the families Neritidae, Littorinidae, Hipponicidae, Janthinidae, Tonnidae, Cassididae, Terebridae, Mitridae, Buccinidae, Harpidae, Cymatiidae, Bursidae, Thaididae, and Coralliophilidae are listed below. The families Cypraeidae and Conidae were treated in the previous two articles of the series.

Family NERITIDAE

Nerita plicata Linnaeus, 1758
Living specimens common near upper limit of high tides on north side of island; clustered on light grayish, superficially bare (though probably algae-covered), rock surfaces protected by eroded crevices and permanently settled boulders of beach rock; associated with lowest shoreline occurrences of Littorina schmitti.

Family LITTORINIDAE

Littorina schmitti Bartsch and Rehder, 1939
Living specimens abundant on all sides of island on protected rock surfaces similar to those which support Nerita plicata but located higher on shore; reached by spray from high tide waves.

Family HIPPONICIDAE

Hipponix antiquatus (Linnaeus, 1758)
Few abraded shells in beach deposits and as fossils in shallow water deposits on north side of lagoon.

Hipponix fimbriata Bartsch & Rehder, 1939
Abundant living specimens among coral boulders of inner part of intertidal reef flat, at outer edge of reef flat, and to depths of at least 40 meters (130 feet), the lower limit of collections.

Hipponix pilosus (Deshayes, 1832)
Distribution similar to that of H. fimbriata.

Family JANTHINIDAE

Janthina janthina (Linnaeus, 1758)
Pelagic, few dead specimens on beach.

Family TONNIDAE

Malea ringens (Swainson, 1822)
Few dead specimens and fragments of specimens on beach, south and west sides of island.

Family CASSIDIDAE

Cassis (Cypraecassis) tenuis Wood, 1828
Few dead specimens and fragments of specimens on beach, east and northwest sides of island; possibly responsible for predation on common sea urchin, Tripneustes gratilla, many tests of which bear single small perforation on side or upper surface (Limbaugh, verbal communication).

Family TEREBRIDAE

Terebra crenulata interlineata Deshayes, 1859
Fresh but dead specimen on patch of coral sand off northwest side of island at depth of about 21 meters (70 feet); few abraded shells in beach deposits on same side of island.

Family MITRIDAE

Mitra edentula Swainson, 1823
Few abraded shells on shore.

Mitra effusa Swainson in Broderip, 1836
Several moderately fresh shells in beach deposits.

Mitra ferruginea Lamarck, 1811
Few abraded and several fresh shells in beach deposits on all sides of island.

Mitra cf. M. lignaria Reeve, 1844
Several abraded shells in beach deposits.

Mitra papalis (Linnaeus, 1758)
Few shells, some fresh and some severely abraded, in beach deposits on all sides of island.

Family BUCCINIDAE

Cantharus sanguinolentus (Duclos, 1833)
One abraded shell in beach deposits on west side of island.

Family HARPIDAE

Harpa gracilis Broderip & Sowerby, 1829
Several abraded specimens in storm wave debris on north side of island.

Family CYMATIIDAE

Cymatium nicobaricum (Röding in Bolten, 1798)
One fresh shell in beach drift on northwest side of island.

Cymatium vestitum (Hinds, 1844)
Fresh shells fairly common on beaches on north and west sides of island.

Family BURSIDAE

Bursa cruentata (Sowerby, 1841)
Living specimens among coral and coral debris off north side of island at depths exceeding 10 meters (35 feet); abraded specimens uncommon on shore except in storm wave debris on north side of island.

Bursa granularis affinis (Broderip & Sowerby, 1833)
Living specimens common among coral boulders of reef flat on south side of island and off edge of reef flat on north side of island to depth of about 12 meters (40 feet); abraded specimens abundant on shore on all sides of island.

Bursa granularis (Röding in Bolten, 1798)
Moderately fresh shells generally common in shore deposits.

Family THAIDIDAE

Nassa francolinus (Bruguière, 1789)
Beach-worn specimens fairly common on north and south sides of island.

Drupa morum Röding in Bolten, 1798
One slightly abraded specimen in storm-washed area on north side of island.

Drupa ricina (Linnaeus, 1758)
Abraded specimens in beach deposits on north side of island and on sand patch off northwest side of island at depth of about 21 meters (70 feet).

Drupa ricina albolabris (Blainville, 1832)
Abundant living specimens among boulders and coral debris of reef flat, especially on seaward parts of flat; common living specimens in coral and coral debris off outer edge of reef flat to depth of at least 40 meters (130 feet), the lower limit of collections; living specimens generally clustered on coral rocks exposed to harsher wave action than those on which Morula uva occurs in comparable abundance.

Morula uva (Röding in Bolten, 1798)
Abundant living specimens on reef flat; common living specimens off outer edge of reef flat to depth of about 20 meters (65 feet).

Morula uva aspera (Lamarck, 1816)
Occurrence cited by Keen, 1958 (Sea Shells of Tropical West America, Stanford University Press).

Thais haemastoma biserialis (Blainville, 1832)
Few abraded specimens in beach deposits.

Thais planospira (Lamarck, 1822)
Few living specimens under coral boulders along inner edge of reef flat on north side of island.

Thais speciosa (Valenciennes, 1832)
Several abraded shells in storm wave deposits on north side of island.

Purpura patula pansa Gould, 1853
One living specimen from under coral boulder on inner part of reef flat, north side of island.

Family CORALLIOPHILIDAE

Coralliophila violacea (Kiener, 1835)
Living specimens common on living coral (Porites) and in coral debris on outer part of reef flat and offshore at least to depth of 18 meters (60 feet).

Magilus robillardi Lienard, 1870
Abraded shells from beach deposits.

Quoyula madreporarum (Sowerby, 1834)
Living specimens imbedded in coral (Pocillopora) on reef flat and off edge of reef flat to depth of at least 18 meters (60 feet).

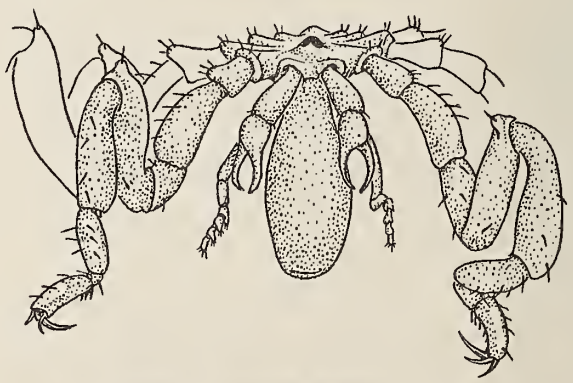
A Pycnogonid Infestation of *Mytilus californianus*

by

Peter H. Benson & Dustin D. Chivers
San Francisco State College, San Francisco, California
California Academy of Sciences, San Francisco, California

(Plate 3)

Thirty-two specimens of Mytilus californianus Conrad were collected by the authors at Duxbury Reef (37°53'30" N., 122°42' W.), Marin County, California, on February 20, 1960. Upon examination, 16 of the 32 mussels exhibited infestation by the pycnogonid Achelia chelata (Hilton, 1939) (=Ammothea euchelata Hedgpeth, 1940). A total of 89 pycnogonids were counted, the incidence ranged from one to 21 parasites per host. The latter specimen is illustrated in plate 3, fig. 1. Immature and apparently mature parasites of both sexes were represented. Obvious destruction to the host's ctenidial and gonadal tissue was evident (see plate 3, fig. 2). Damage to the visceral mass, foot and palps was also apparent in several mussels. In the specimen exhibiting the greatest amount of damage, there was a complete loss of ctenidia and the major portion of mantle and gonadal tissue, accompanied by apparent atrophy of the entire animal. It is of interest to note that a group from Chico State College under the direction of Dr. Rodgers examined over 50 specimens of Mytilus californianus from Tomales Point, Marin County, on May 1, 1960, and found no pycnogonids. They did, however, encounter a high incidence of the pea crab Fabia subquadrata Dana within the bivalves. This commensal was not encountered in the mussels examined by us. Another commensal pea crab, Pinnotheres latissimus Bürger, was encountered by Ohshima (1935) in Japan during his examinations of Paphia. In this latter case the presence of these crabs seemed in no way to interfere with the parasitism by pycnogonids mentioned later in this report.



Textfigure 1: *Achelia chelata* (Hilton) Frontview of Holotype of *Ammothea euchelata* Hedgpeth. Reproduced with permission from J. W. Hedgpeth, Jour. Wash. Acad. Sci., 1940, figure 1, page 85.

Achelia chelata was reported by Hilton (1939) as occurring on the central California Coast. Hedgpeth (1940) collected a male of this species (text fig. 1) from Bugula at Pescadero, San Mateo County, California. An occurrence has also been recorded from Moss Beach, San Mateo County, California (S. F. Light, et al., 1957). Ziegler (1960) collected a specimen of A. chelata on the rock substrate under a Mytilus bed at Duxbury Reef, Marin County, California.